INFLUENCING FACTORS FOR THE MEASURING RESULTS. ERROR SOURCES AND SOME POSSIBILITIES TO REDUCE FOR THOSE ERRORS

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Abstract: The study presented by this papers depicts the problems who affect the normal weighing process when the weighing instruments are using in different situations such as temperature changes, vibration, magnetic interference, electromagnetic interference. That factors influenced especially balances with high accuracy, such as analytical and microanalytical balances, but can be affected by errors truck scales or rail scales.
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1. INTRODUCTION

Measuring results can be affect by a number of factors, such as:
- weighing method factors ;
-weighing equipment factors;
-environmental factors ;
-human factor

The scale and balances are presented everywhere: in industry, trade, laboratory, agriculture etc. Every weighing are affected by errors. Many of them can be avoid or reduce.
The measurement technology grow up. A lot of sofiphisticated weighing instruments gifted with performances calibrated systems and levelling sensors. In the future, the number mechanical balances will be reduced, because the electronic balances have a lot of advantage such as : possibility to memorised prices, possibility to calibrated in short time, and many same this.

2. INFLUENCING FACTORS FOR THE MEASURING RESULTS

2.1 Weighing method factors

Weighing method factors-can be the most frequently factor influencing measuring results.

Falling to ensure proper installation such as using the balances when the level is not horizontal.

The importance of levelling a balance will be explained by using the following example: it was followed same weights class F2 to verify a electronic balance of Class II accuracy with following characteristics: maximum capacity :Max=3100g; minimum capacity: Min=o,5g ; resolution d=0,01g; verification scale interval: e=0,1g.

For a horizontally level, the results obtained are in following table:

Table1 The experimentally obtained results

Nominal mass value (g)	Balance's indication (g)
10	10,00
50	50,00
100	100,00
200	200,00
500	499,99
1000	999,96
2000	1999,94

Maximum permissible errors for electronic balances of Class II accuracy, are:

-Min=0,5g ≤m≤500g : E=±0,5e=±0,05g ;

- 500g<m≤2000g : E=±1e=±0,1g ;

-2000g<m≤Max=3100g : E=±1,5e=±0,15g

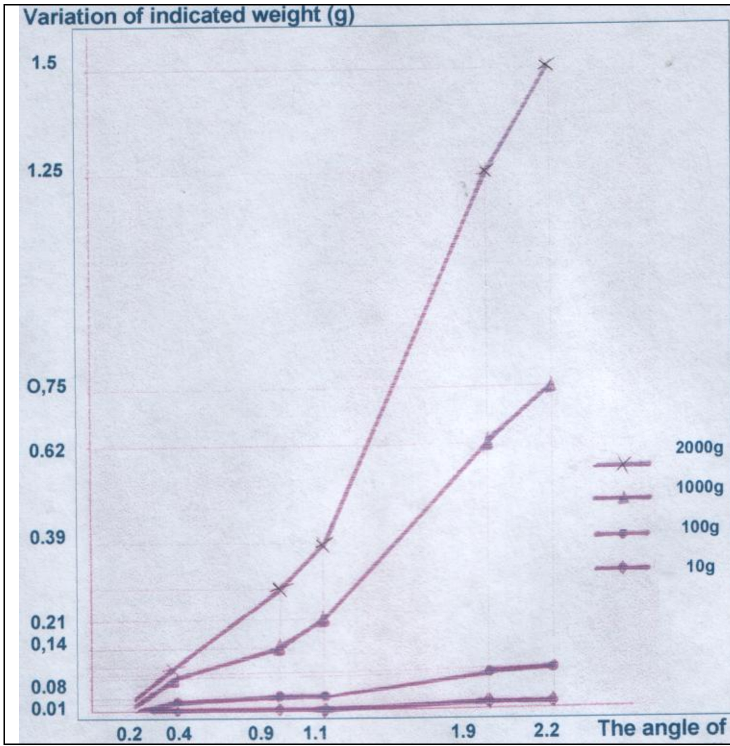
where: m- nominal mass value (g) off load applied ;

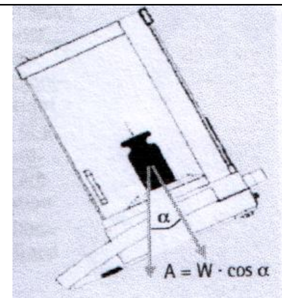
E- maximum permissible errors for electronic balances of Class II accuracy

Table 2 The maximum permissible errors.

Nominal mass value	Variation of indicated weight / Angle of inclination of balance					
g	0,2°	0,4°	0,9°	1,1°	1,9°	2,2°
10	0	0	0	0	0,01	0,01
50	0	0	0,01	0,01	0,04	0,04
100	0	0,01	0,02	0,02	**0,07**	**0,08**
200	0,01	0,01	0,04	0,05	**0,12**	**0,15**
500	0,01	0,02	**0,07**	**0,10**	**0,30**	**0,39**
1000	0,01	0,03	**0,14**	**0,21**	**0,62**	**0,75**
2000	0,02	0,07	**0,28**	**0,39**	**1,25**	**1,5**

In the table above, the values written bold characters overtaken the maximum permissible errors.

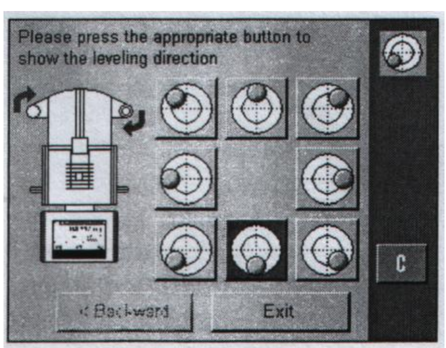


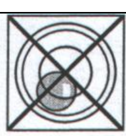


For different inclined angles of balance obtained with a set of gauge blocks, it was determined the values of the same weights class F2.

The results obtained are given in the table above.

The values with bold characters are biger than permissible errors.





When the level sensor detects that the level is incorrect, the warning text will appear („ The balances is inclined. Please level the balance“) and a warning beep will sound. The Levelling Assistant of the balance will show you with arrows which direction you need to turn the two levelling foots on the back of the balance. A status icon with level indicator will also appear in the upper right hand corner of the display.

For levelled correctly, it must turn the levelling foots in the direction indicated until the air bubble is in the inner circle of the level indicator.

2.2. Weighing equipment factors

Examples: frictions in a measuring instrument that has mobile components.

2.3 Environmental factors

Environmental factors-can disturb the weighing, such as vibrations or excessive temperature fluctuations, direct sunlight.

Other sources of error can be the effect of moving the balance to a different location.

If a gravity sensitive instrument is verified at a location which is different from that where the instrument is used then the different values of the acceleration due to gravity, the g-values, of the two locations are a source of error.

Gravitational acceleration is greatest at the poles, least at the equator and decreases with altitude.

Gravity from equator to pole increases at mean sea level by 0,53%. This is basically caused by the spinning globe which produces centrifugal forces which are at maximum at the equator and zero at the poles. These forces act against the gravitational force and therefore gravity is reduced as one moves from pole to equator.

A further factor is that the word has a larger diameter at the equator than the pole. This difference at mean sea level is 33km. As gravitational pull reduces as distance from the earth’s centre is increased, gravity is therefore further reduced from pole to equator to give the total difference of 0,53%.

Of lesser effect is altitude variation. Gravity varies by 0,03% for every 1000 meters change in height. For gravity sensitive scales to vary by just one division in a thousand their location must be changed by 3300 meters in height. [3]

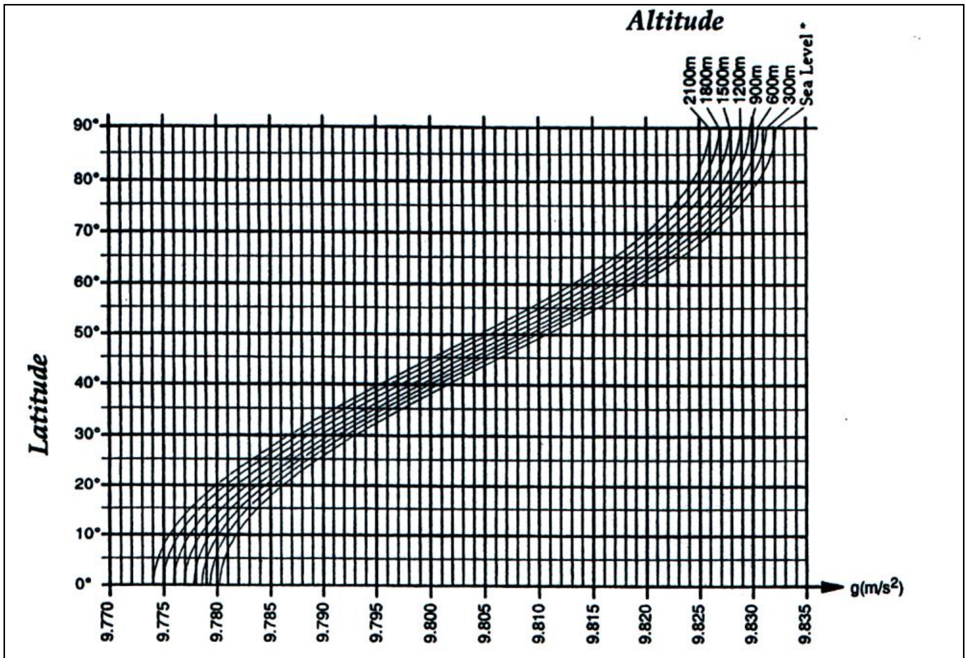


Fig.1 Gravity Acceleration Chart

Table2.The values of gravity at various locations:

Amsterdam	9,813 m/s²	New York	9,802 m/s²

Atena	9,800 m/s²	Oslo	9,819 m/s²
Bruxel	9,811 m/s²	Paris	9,809 m/s²
Chicago	9,803 m/s²	Rio de Janeiro	9,788 m/s²
Frankfurt	9,810 m/s²	Roma	9,803 m/s²
Helsinki	9,819 m/s²	San Francisco	9,800 m/s²
Londra	9,812 m/s²	Stockolm	9,818 m/s²
Los Angeles	9,796 m/s²	Sydney	9,797 m/s²
Madrid	9,800 m/s²	Tokyo	9,798 m/s²
Milano	9,806 m/s²	Washington	9,784 m/s²

The acceleration due to gravity at any particular latitude may be computed from the formula: $g=G(1+b\sin^2\Phi-d\sin^2 2\Phi)-3{,}086\times10^{-6}\,H \quad (m/s^2)$

where Φ=latitude ; H=height in metres above sea level,
G=gravity at Equator=9,7803184 m/s²
b=0,0053024 ; d=0,0000059

Modern weighing instruments can be calibrated, internal or external, automatically or manually.

Calibration (adjusment to the acceleration due to gravity) is necessary on first-time startup and after every location change, to obtain precise results.

Calibration is required any time the ambient conditions (temperature, humidity or air pressure) change or the balance has been leveled.

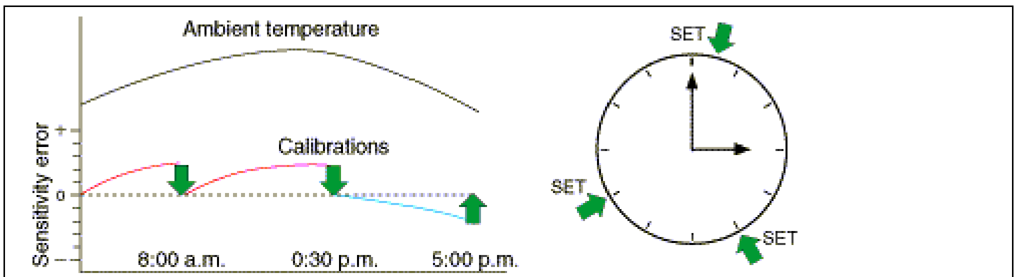


Fig.2 Automatic calibration at user-preset times.

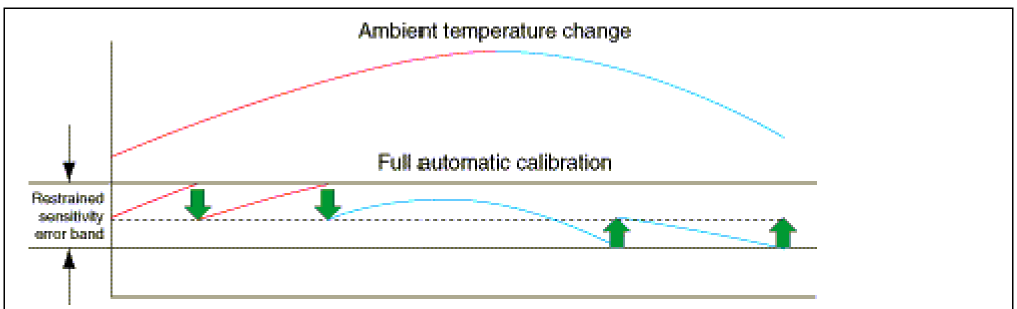
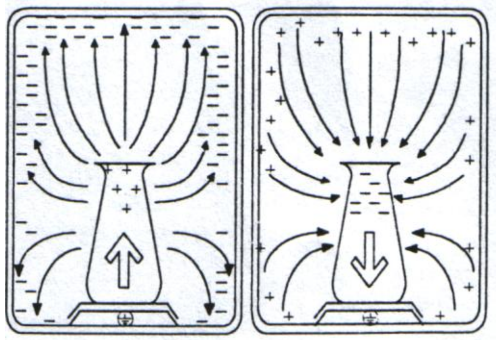


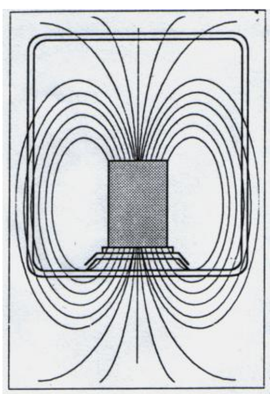
Fig.3 Full automatic calibration : the balance automatically chooses the best measuring mode corresponding to the temperature, current load, vibration and other environmetal conditions

Electrostatic fields can cause errors in measurements. If there is a static charge in a mechanical balance, the balance may give erratic readings and lack repeatability. If the obiect being weighed has a significant electrostatic charge, it may rezult in measurement errors and may leave a static charge on the balance. To prevent the build-up of static electricity in a balance, the relative humidity in the laboratory should be maintained between 40% and 60%.The water vapor in the air will serve to drain off electrostatic charges from the balance.



This charging frequently appears in heated rooms with dry air (less than around 40% relative humidity) and with weighing samples made of glass or plastic.

Electrostatic charging generates forces wich can disturb the weighing. This leads to constantly changing and unstable display results.



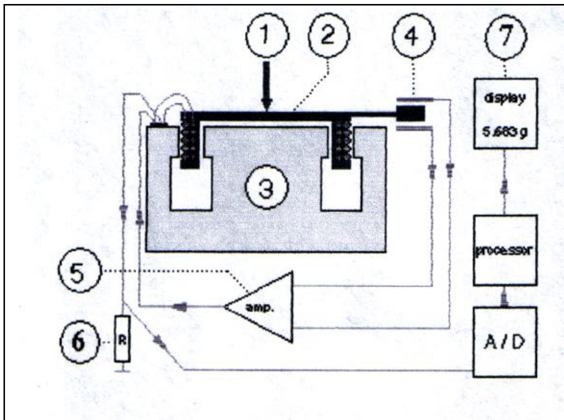
The magnetism of a weighing sample can lead to the weighing result being dependent on the position of the weighing sample on the weighing pan and to a result that is difficult to reproduce.

Magnetic forces are interpreted wrongly by the balance as an additional load.

In simple cases it may suffice to increase the separation between the weighing sample and the weighing pan by placing the weighing sample on a nonmagnetic metal (aluminium) or glass vessel.

Balances utilizing the magnetic force restoration principle for weighing should be checked to verify that the magnetic field generated by the magnetic cell in the balance does not exist around the balance pan. If the shielding of the magnetic cell is inadeqvate, measurement errors may occur when weighing ferromagnetic objects or when the balance is placed on a surface comprised of ferromagnetic material.

	1-direction of the force being measured (and compensated) ;

	2-coil ; 3-permanent magnet ; 4-position sensor (null sensor) ; ussually a photo cell or capacitive sensors ; 5-servo amplifier ; 6-precizion rezistor (measuring rezistor) ; 7-digital display
Fig.4 The force transducer utilizing the magnetic force	

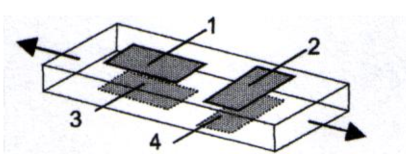
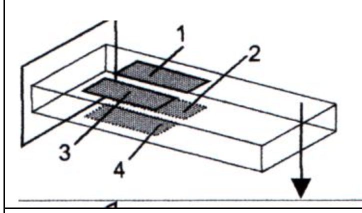
The force on the weighing pan is compensated by the permanent magnet and the magnetic field generated by the currentin the coil. This current is regulated by the sensitive position sensor and the servo amplifier, and mesured over the precision rezistor by the analog-digital converter. The balance measures the current needed to keep the pan in its position and the pan does not move. [2]

In most cases, four strain gages are used to obtain maximum sensitivity and temperature compensation. Two of the gauges are usually in tension, and two in compression.

The strain gauge load cell become established as the most widely used load transducer in all areas of weight measurement from retail scales process industry through to medical applications.

Strain gauge load cells convert the load acting on them into electrical signals. The gauges themselves are bonded onto a beam or structural members that deforms when is applied.

The table below shows some of the most common situations:

	Compensates for temperature and reject bending strain.
Fig.5 Bridge Configurations for Uniaxial Members	
	Maximum sensitivity for bending ; reject axial strains ; temperature compensated.
Fig.6 Bridge Configurations for Flexural Members	

2.4 Human factor

Human factor-can disturb the weighing with a parallax errors. That factor disappears when is following electronic balances and scales.

3. CONCLUSIONS

There are many possible sources of uncertainty in a balance or a scale. Some factors can be evaluated and quantified.

The performances of a balance is affected if the instruments are using incorrect.

Is important that uncertainties be identified or eliminated to the extent possible.

We may conclude that is not enough to use a balance or a scale with good uncertainty and a small errors, it must to evaluated and quantified the possible source of uncertainties and try to avoid her.

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